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In re application of:	: Confirmation No. 2353
Rodney James DRY	:
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Filed: April 12, 2004	:
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Serial No.: 10/821,947	:
	:
For: Direct Smelting Plant and Process	:

McLean, Virginia
August 12, 2004

SUBMISSION OF CERTIFIED COPY OF PRIORITY APPLICATION IN SUPPORT OF CLAIM FOR PRIORITY

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

In the matter of the above-identified application, a claim for priority has previously been made under the provisions of 35 U.S.C. 119 for the benefit of the filing date of the corresponding Australian Application No. 2003901693 filed 10 April 2003, which is referred to in the Declaration of the present case.

A certified copy of said Australian application is filed herewith in support of said claim.

Respectfully submitted,

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Australian Government

Patent Office
Canberra

I, JULIE BILLINGSLEY, TEAM LEADER EXAMINATION SUPPORT AND SALES hereby certify that annexed is a true copy of the Provisional specification in connection with Application No. 2003901693 for a patent by TECHNOLOGICAL RESOURCES PTY LTD as filed on 10 April 2003.

COMMONWEALTH OF AUSTRALIA
AUSTRALIA
PATENT OFFICE

WITNESS my hand this
Twenty-second day of April 2004

J. Billingsley

JULIE BILLINGSLEY
TEAM LEADER EXAMINATION
SUPPORT AND SALES

CERTIFIED COPY OF PRIORITY DOCUMENT

AUSTRALIA

Patents Act 1990

PROVISIONAL SPECIFICATION

Applicant(s):

TECHNOLOGICAL RESOURCES PTY LTD

A.C.N. 002 183 557

Invention Title:

DIRECT SMELTING PROCESS AND PLANT

The invention is described in the following statement:

DIRECT SMELTING PLANT AND PROCESS

TECHNICAL FIELD

The present invention relates to a direct smelting plant and process for producing molten metal from a metalliferous feed material such as ores, partly reduced ores and metal-containing waste streams.

A known direct smelting process, which relies principally on a molten bath as a reaction medium, and is generally referred to as the HIsmelt process, is described in International Application PCT/AU96/00197 (WO 96/31627) in the name of the applicant.

The HIsmelt process as described in the International application in the context of producing molten iron includes:

(a) forming a bath of molten iron and slag in a vessel;

(b) injecting into the bath:

(i) a metalliferous feed material, typically iron oxides; and

(ii) a solid carbonaceous material, typically coal, which acts as a reductant of the iron oxides and a source of energy; and

(c) smelting metalliferous feed material to iron in the metal layer.

The term "smelting" is herein understood to mean thermal processing wherein chemical reactions that reduce

metal oxides take place to produce molten metal.

The HIsmelt process also includes post-combusting reaction gases, such as CO and H_2 released from the bath, in the space above the bath with oxygen-containing gas and transferring the heat generated by the post-combustion to the bath to contribute to the thermal energy required to smelt the metalliferous feed materials.

The HIsmelt process also includes forming a transition zone above the nominal quiescent surface of the bath in which there is a favourable mass of ascending and thereafter descending droplets or splashes or streams of molten metal and/or slag which provide an effective medium to transfer to the bath the thermal energy generated by post-combusting reaction gases above the bath.

In the HIsmelt process the metalliferous feed material and solid carbonaceous material is injected into the molten bath through a number of lances/tuyeres which are inclined to the vertical so as to extend downwardly and inwardly through the side wall of the smelting vessel and into a lower region of the vessel so as to deliver at least part of the solids material into the metal layer in the bottom of the vessel. To promote the post-combustion of reaction gases in the upper part of the vessel, a blast of hot air, which may be oxygen enriched, is injected into an upper region of the vessel through the downwardly extending hot air injection lance. Offgases resulting from the post-combustion of reaction gases in the vessel are taken away from the upper part of the vessel through an offgas duct. The vessel includes refractory-lined water cooled panels in the side wall and the roof of the vessel, and water is circulated continuously through the panels in a continuous circuit.

The HIsmelt process enables large quantities of

molten metal, such as molten iron, to be produced by direct smelting in a single compact vessel.

However, in order to achieve this it is necessary to supply large quantities of solid feed materials, such as iron-containing feed materials, carbonaceous material, and fluxes, to the solids injection lances.

The supply of solid feed materials must continue throughout a smelting campaign, which desirably is at least 12 months.

Moreover, it must be possible to vary the supply of solid feed materials during the course of a smelting campaign to accommodate different operating conditions, including unexpected perturbations in the process, at different stages of a smelting campaign.

The present invention provides an effective and reliable process and plant for supplying solid feed materials to solids injection lances during a HIsmelt smelting campaign.

DISCLOSURE OF THE INVENTION

The present invention provides a solids feed means for a direct smelting plant. The solids feed means includes 2 or more pairs of lances for injecting solid feed materials for a direct smelting process into a direct smelting vessel (such as a fixed vertically extending cylindrical vessel). The solids feed means also includes a main supply line and a pair of branch lines for supplying solid feed material to the lances of each pair of lances with the branch lines interconnecting the main supply line and the lances of the pair of lances. The lances are arranged around the vessel in pairs of diametrically opposed lances. At least one pair of lances is provided

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for injecting metalliferous feed material (such as iron-containing materials, particularly iron ore fines) and at least one of the other pairs of lances is provided for injecting solid carbonaceous material (such as coal) and optionally fluxes. The pairs of lances are arranged around the vessel so that adjacent lances are lances that are provided to inject different materials.

According to the present invention there is provided a direct smelting plant for producing molten metal from a metalliferous feed material including:

(a) a fixed smelting vessel to hold a molten bath of metal and slag and a gas space above the bath;

(b) a solids feed means to supply solid feed material into the vessel, the solids feed means includes 2 or more pairs of solids injection lances arranged around and extending into the vessel, and a main supply line and a pair of branch lines for supplying solid feed material to the lances of each pair of lances with the branch lines interconnecting the main supply line and the lances of the pair of lances, and with the lances of each pair of lances being diametrically opposed to each other, and with at least one pair of lances being provided for injecting metalliferous feed material and at least one of the other pairs of lances being provided for injecting solid carbonaceous material, and with the pairs of lances being arranged around the vessel so that adjacent lances are lances that are provided to inject different materials;

(c) a gas injection means extending downwardly into the vessel to inject an oxygen-containing gas into the gas space and/or the bath in the vessel;

(d) a gas delivery duct means extending from a gas supply location away from the vessel to a delivery

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location above the vessel for delivering the oxygen-containing gas into the gas injection means;

(e) an offgas duct means for facilitating flow of offgas from the vessel away from the vessel;

(f) a metal tapping means for tapping molten metal from the bath and transporting that molten metal away from the vessel; and

(g) a slag tapping means for tapping slag from the bath and transporting that slag away from the vessel.

Preferably the solids injection lances are arranged to extend downwardly and inwardly into the vessel through openings in a side wall of the vessel.

Preferably the lance openings in the side wall of the vessel are located at the same height of the vessel and are spaced at equal distances around the circumference of the vessel.

Preferably the solids feed means includes a lance handling means for installing and removing the solids injection lances.

Preferably the branch lines of each pair of solids injection lances are substantially the same length.

Preferably the branch line for each lance includes an upwardly extending section, and an inwardly and downwardly extending section that extends from an upper end of the upwardly extending section and is connected to an inlet of the lance and is coaxial with the lance.

Preferably the upwardly extending section and the inwardly and downwardly extending section describe an acute

angle.

Preferably the solids feed means is adapted to supply one or more of (a) pre-heated metalliferous feed material, (b) metalliferous feed material at ambient temperature, and (c) a blend of pre-heated and ambient temperature metalliferous feed material to the metalliferous feed material lances.

Preferably the solids feed means includes a hot metalliferous feed material injection system for supplying pre-heated metalliferous feed material to the main supply line or lines for the metalliferous feed material lances.

Preferably the hot metalliferous feed material injection system includes a hot metalliferous feed material transfer means that includes the main supply line or lines and a supply of a carrier gas, such as an inert gas, for transporting the hot metalliferous feed material from a pre-heater and/or pre-reduction unit to the metalliferous feed material lances.

Preferably the metalliferous feed material is iron ore fines.

Preferably the hot metalliferous feed material injection system is operable to pre-heat the iron ore fines so that the iron ore fines for injection into the vessel at a temperature in the range of 650-700°C, more preferably of the order of 680°C.

Preferably the plant further includes at least two work platforms for supporting plant operators at different heights of the vessel above ground level.

Preferably the metal tapping means and the slag tapping means are located so as to be accessible by plant

operators on one of the platforms (hereinafter referred to as the "cast house platform").

Preferably the solids injection lances and the solids injection lance handling means are located so as to be accessible by workman on at least one other platform (hereinafter referred to as the "lance extraction platform") that is above the cast house platform.

The metal tapping means and the slag tapping means may be the same unit.

The metal tapping means and the slag tapping means may also be different units with a separate metal tap hole and a separate slag tap hole located at different heights of the vessel.

In situations in which the metal tapping means and the slag tapping means are different units, preferably the metal tapping means includes a metal flow forehearth projecting outwardly from the vessel for tapping molten metal continuously from the vessel.

With this arrangement, preferably the metal tapping means includes a metal tapping launder for receiving molten metal from the forehearth.

In addition, with this arrangement, preferably the slag tapping means includes a slag tapping launder for receiving molten slag from the bath.

Preferably the vessel is disposed about a central upright axis and the zones radiate outwardly of the central axis outside the vessel.

Preferably the vessel is a vertical cylindrical vessel and the plurality of solids injection lances are

spaced circumferentially around the vessel.

Preferably the side wall of the vessel includes water-cooled panels.

Preferably the vessel includes a roof and the roof includes water-cooled panels.

Preferably the oxygen-containing gas is air or oxygen-enriched air.

According to the present invention there is provided a direct smelting process that includes injecting solids feed materials into a direct smelting vessel containing a molten bath of metal and slag through 2 or more pairs of solids injection lances arranged around and extending into the vessel, and a main supply line and a pair of branch lines for supplying solid feed material to the lances of each pair of lances with the branch lines interconnecting the main supply line and the lances of the pair of lances, and with the lances of each pair of lances being diametrically opposed to each other, and with at least one pair of lances injecting metalliferous feed material and at least one of the other pairs of lances injecting solid carbonaceous material and optionally fluxes, and with adjacent lances injecting different materials.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention is described in more detail hereinafter with reference to the accompanying drawings, of which:

Figure 1 is a vertical cross-section through a direct smelting vessel that forms part of one embodiment of a direct smelting plant in accordance with the present

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invention;

Figure 2 is a side elevation of the vessel and the arrangement of platforms around the vessel and the equipment on the platforms that form a major part of the embodiment of the direct smelting plant;

Figure 2a is an enlarged side elevation of the solids injection lance and hot ore supply lines indicated by the arrow "A" in Figure 2;

Figure 3 is a side elevation of a lower part of the vessel and the arrangement of platforms around the vessel and the equipment on the platforms that form a major part of the embodiment of the direct smelting plant viewed from a location that is 90° from the location from which the vessel is viewed from in Figure 2;

Figure 4 illustrates the layout of the cast house platform of the embodiment of the direct smelting plant;

Figure 5 illustrates the layout of the end tap platform of the embodiment of the direct smelting plant;

Figure 6 is a computer-generated top plan view of the embodiment of the direct smelting plant which illustrates the cast house platform and equipment on that platform and a section through the vessel at that height of the vessel and equipment above that platform and with equipment above that platform removed to clarify the view of the plant;

Figure 7 is a computer-generated top plan view of the embodiment of the direct smelting plant from the same location as Figure 6 which illustrates some of the equipment of the plant shown in Figure 6 and equipment of the plant not shown in Figure 6 and a top view of the

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vessel and with equipment removed to clarify the view of the plant; and

Figure 8 is a diagrammatic plan of the arrangement of solids injection lances around the vessel the supply lines for the lances.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The direct smelting plant shown in the Figures includes a direct smelting vessel that is suitable particularly for operation by the HIsmelt process as described in International patent application PCT/AU96/00197. The following description is in the context of smelting iron ore fines to produce molten iron in accordance with the HIsmelt process.

With reference initially to Figure 1, the metallurgical vessel is denoted generally as 11 and has a hearth that incudes a base 12 and sides 13 formed from refractory bricks, side walls 14 which form a generally cylindrical barrel extending upwardly from the sides 13 of the hearth and which include an upper barrel section and a lower barrel section formed from water-cooled panels (not shown), a roof 17 formed from water-cooled panels (not shown), an outlet 18 for offgases, a forehearth 19 for discharging molten metal continuously, and a tap-hole 21 for discharging molten slag during smelting.

In use of the vessel to smelt iron ore fines to produce molten iron in accordance with the HIsmelt process, the vessel 11 contains a molten bath of iron and slag which includes a layer 22 of molten metal and a layer 23 of molten slag on the metal layer 22. The arrow marked by the numeral 24 indicates the position of the nominal quiescent surface of the metal layer 22 and the arrow marked by the numeral 25 indicates the position of the nominal quiescent

surface of the slag layer 23. The term "quiescent surface" is understood to mean the surface when there is no injection of gas and solids into the vessel.

As can best be seen in Figures 2 and 3, the vessel includes a series of platforms 79, 81, 83, 85 at different heights of the vessel above ground level 87. The platforms enable installation and operation of vessel and other plant equipment described hereinafter around the compact vessel 11 in a way which separates the various operational functions of the equipment so as to minimise interference between the various operations and, accordingly, maximising operational safety. The heights of the platforms 79, 81, 83, 85 are selected to enable workman on the platforms to have convenient access to the plant equipment. In addition, the "footprints" of the platforms 79, 81, 83, 85 are selected to permit overhead crane access to selected areas of lower platforms and to provide overhead protection for work areas of the lower platforms.

As is discussed in further detail hereinafter, the platforms 79, 81 are solids injection lance extraction platforms, the platform 83 is a cast house platform, and the platform 85 is an end tap platform.

As can best be seen in Figure 5, the vessel 11 includes 2 access doors 39 in the sides 13 of the hearth for allowing access to the interior of the vessel 11 for re-lining or other maintenance work in the interior of the vessel. The access doors 39 are in the form of steel plates that are welded to the sides 13. When access to the interior of the vessel is required, the plates are cut away from the side walls and replacement plates are welded in position after the work in the vessel has been completed. The access doors 39 are at the same height of the vessel 11. The access doors 39 are spaced at least 90° apart around the circumference of the vessel. This spacing makes

it possible for refractory wall demolition equipment to extend through the doors into the vessel and demolish a substantial part of the refractories of a refractory-lined side wall while the vessel is hot. The access doors 39 are sufficiently large to allow bob-cat 139 or similar equipment access to the interior of the vessel.

As can best be seen in Figure 1, the vessel 11 is fitted with a gas injection lance 26 for delivering a hot air blast into an upper region of the vessel. The lance 26 extends downwardly through the roof 17 of the vessel 11 into the upper region of the vessel. In use, the lance 26 receives an oxygen-enriched hot air flow through a hot gas delivery duct 31 (Figures 2, 6 and 7) which extends from a hot gas supply station (not shown) located some distance away from the reduction vessel 11. The hot gas supply station includes a series of hot gas stoves (not shown) and an oxygen plant (not shown) to enable an oxygen enriched air stream to be passed through the hot gas stoves and into the hot gas delivery duct 31 which extends to a connection with the gas injection lance 26 at a location above the vessel 11. Alternatively oxygen may be added to the air stream after the air stream has been heated by the stoves.

With reference to the Figures generally, the vessel 11 is also fitted with 8 solids injection lances 27 extending downwardly and inwardly through openings (not shown) in the side walls 14 of the vessel and into the slag layer 23 for injecting iron ore fines, solid carbonaceous material, and fluxes entrained in an oxygen-deficient carrier gas into the metal layer 22.

The lance openings in the side walls 14 of the vessel are located at the same height of the vessel 11 and are spaced at equal distances around the circumference of the vessel. The lances 27 are formed and are located in the lance openings so that their outlet ends 28 are above

the surface of the metal layer 22 during operation of the process. This position of the lances 27 reduces the risk of damage through contact with molten metal and also makes it possible to cool the lances by forced internal water cooling without significant risk of water coming into contact with the molten metal in the vessel.

The lances 27 are in 2 groups of 4 lances, with the lances 27 in one group receiving hot iron ore fines supplied via a hot ore injection system and the lances 27 in the other group receiving coal and flux via a carbonaceous material/flux injection system during a smelting operation. The lances 27 in the 2 groups are arranged alternately around the circumference of the vessel.

The hot ore injection system includes a pre-heater (not shown) for heating the iron ore fines and a hot ore transfer system that includes a series of supply lines and a supply of carrier gas for transporting the hot ore fines in the supply lines and injecting the hot ore fines at a temperature of the order of 680°C into the vessel. The general arrangement of the lances 27 and the supply lines immediately upstream of the lances 27 is shown diagrammatically in Figure 8.

With reference to the Figures generally, the hot ore injection system includes a main hot ore supply line 75 (Figures 2 to 5) and 2 branch lines 76 (Figures 2 to 4) that are connected to diametrically opposed lances 27 and are arranged to supply hot ore to these lances 27 during a smelting operation. The hot ore injection system also includes another main hot ore supply line 33 (Figures 2 and 5) and 2 branch lines 34 (Figures 2 to 5) that are connected to the other pair of diametrically opposed lances 27 and are arranged to supply hot ore to these lances 27.

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As can be seen in Figures 2 to 5, the main supply line 75 runs on or close to ground level from a remote location (not shown) away from the vessel and under the end tap platform 85 to a location 75a in Figures 2 and 3 and then vertically upwardly from this location through the end tap platform 85 and the cast house platform 83 to a location 75b in Figures 2 to 4 above the cast house platform 83. The branch lines 76 initially extend horizontally in opposite directions from the main line 75 at the location 75b and then vertically upwardly at locations 76a (Figures 2 and 3) to locations 76b (Figures 2 to 4) and then inwardly and downwardly in short straight sections 76c to the inlets of lances 27.

As can also be seen in Figures 2 and 3, the main supply line 33 runs on or close to ground level from a remote location (not shown) away from the vessel to a location 33a in Figure 5 and the line branches into the branch lines 34 at this location. These branch lines define a V-shape. The branch lines 34 extend on or close to ground level under the end tap platform 85 to locations 34a (Figures 2 and 3) and then vertically upwardly from these locations through the end tap platform 85 and the cast house platform 83 to the locations 34b (Figure 2) and then inwardly and downwardly in short straight sections 34c (Figure 2, only one shown) to the inlets of lances 27.

The above-described arrangement of the pairs of main and branch lines avoids interference between the lines in the confined space around the vessel.

The carbonaceous material/flux injection system includes similar main supply lines 39, 91 and branch supply lines 40, 92, respectively for diametrically opposed pairs of the lances 27.

The lances 27 are arranged to be removable from

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the vessel 11 by means of lance handling equipment associated with each lance 27 that can support the lances 27 for installation in openings provided in the side walls 14 of the vessel and for withdrawal of the lances 27 from the vessel. The lance handling equipment is partially shown in the Figures. With reference to Figures 2a and 3, the lance handling equipment for each lance includes a guide arm 113 that extends upwardly and outwardly from the vessel and is adapted to support and guide the lance as a lifting unit (not shown) lifts the lance into and from the vessel opening for the lance.

The offgas outlet 18 of the vessel 11 is connected to an offgas duct 32 (shown in Figures 2, 6 and 7) which transports the offgas away from the vessel 11 to a treatment station (not shown) where it is cleaned and passed through heat exchangers for preheating the materials fed to the vessel 11. The HIsmelt process preferably operates with air or oxygen-enriched air and therefore generates substantial volumes of offgas and requires a relatively large diameter offgas duct 32. As can best be seen in Figure 2, the offgas duct includes a gently inclined first section 32a extending from the offgas outlet 18 of the vessel 11 and a vertically extending second section 32b that extends from the first section 32a.

The hot gas delivery duct 31 and the offgas duct 32 extend away from the upper part of the vessel 11 to remote locations (not shown) and therefore occupy space in that region of the vessel and therefore have an impact on the positioning of plant equipment such as overhead cranes or other mobile handling equipment that is required for maintenance of the vessel and a cooling water circuit for the water-cooled panels in the side walls 14 and the roof 17 of the vessel 11.

As is indicated above, the side walls 14 and the

roof 17 of the vessel 11 are formed from water-cooled panels (not shown) and the plant includes a cooling water circuit. The cooling water circuit supplies water to and removes heated water from the water-cooled panels and thereafter extracts heat from the heated water before returning the water to the water-cooled panels.

With reference to Figure 7, the supply side of the circuit includes a main supply pipe 101 that supplies water to a horizontally-disposed U-shaped inlet manifold 99 located above the roof 17 of the vessel 11 and a network of pipes that distributes water from the manifold 99 to water inlets in the panels in the roof 17 and the side walls 14 of the vessel.

The return side of the circuit includes a network of pipes that receives heated water from water outlets in the panels in the roof 17 and the side walls 14 of the vessel and delivers the water upwardly to a horizontally-disposed U-shaped outlet manifold 105 located above the roof 17 of the vessel 11 at the same height as the inlet manifold 99. The return side of the circuit also includes a main return line 107 that transfers heated water from the outlet manifold 105 to a heat exchanger (not shown).

The location and large diameter of the offgas duct 32 constrains the inlet and outlet manifolds 99, 105 to the U-shaped configuration shown in Figure 7.

In a smelting operation in accordance with the HIsmelt process, ore fines and a suitable carrier gas and coal and a suitable carrier gas are injected into the molten bath through the lances 27. The momentum of the solid materials and the carrier gases causes the solid materials to penetrate the metal layer 15. The coal is devolatilised and thereby produces gas in the metal layer 15. Carbon partially dissolves in the metal and partially

remains as solid carbon. The ore fines are smelted to metal and the smelting reaction generates carbon monoxide. The gases transported into the metal layer and generated by devolatilisation and smelting reactions produce significant buoyancy uplift of molten metal, solid carbon and slag (drawn into the metal layer as a consequence of solid/gas/injection) from the metal layer 15 which generates upward movement of splashes, droplets and streams of molten metal and slag, and these splashes, droplets and streams entrain slag as they move through the slag layer. The buoyancy uplift of molten metal, solid carbon and slag causes substantial agitation of the slag layer 16, with the result that the slag layer expands in volume. In addition, the upward movement of splashes, droplets and streams of molten metal and slag - caused by buoyancy uplift of molten metal, solid carbon and slag - extend into the space above the molten bath and forms a transition zone. Injection of the oxygen-containing gas via the lance 26 post-combusts reaction gases, such as carbon monoxide and hydrogen, in the upper part of the vessel. Offgases resulting from the post-combustion of reaction gases in the vessel are taken away from the upper part of the vessel through the offgas duct 32.

Hot metal produced during a smelting operation is discharged from the vessel 11 through a metal tapping system that includes the forehearth 19 and a hot metal launder 41 connected to the forehearth. The outlet end of the hot metal launder 41 is positioned above a hot metal ladle station (not shown) so as to supply molten metal downwardly to ladles located at the station.

The plant includes an end metal tapping system for tapping molten metal from the vessel 11 at the end of a smelting operation out of the lower part of the vessel and transporting that molten metal away from the vessel 11. The end metal tapping system includes a metal end tap hole

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63 in the vessel and a launder 38 for transferring molten metal discharged from the vessel 11 via the tap hole to a containment metal pit 91 at ground level. Ideally this pit 91 is covered (not shown) from the elements to prevent direct contact between hot metal in the pit and water. The end metal tapping system also includes a metal tap hole 43 in the forehearth 19 and a launder 40 for transferring molten metal discharged from the forehearth 19 via the tap hole to the main hot metal launder 38. An end tap drill 59 is also provided to open the tap holes 63, 43 to release metal from the vessel and the forehearth.

The plant includes a slag tapping system for tapping molten slag from the vessel 11 periodically from the lower part of the vessel and transporting that slag away from the vessel 11 during a smelting operation. The slag tapping system includes a slag notch 21 in the vessel 11 and a launder 44 with 2 end branches 80, 82 for transferring molten slag discharged from the vessel 11 via the slag notch 21 downwardly from the height of the end tap platform 85 into separate slag containment pits 93, 95 at ground level 87. Two pits are provided so that one pit can be out of service and allowed to cool down prior to the slag being removed while the other pit is in service and receiving molten slag. A slag notch plug and pricker machine 61 is provided to open and seal the slag notch 21 to release slag from the vessel 11.

The plant includes a slag tapping system for draining slag from the vessel 11 at the end of a smelting operation. The slag end tapping system includes a slag tap hole 46 in the vessel 11 and a main launder 70 and a branch launder 72 for transferring molten metal discharged from the vessel 11 via the slag tap hole 46 to the containment pit 93. A branch launder 95 connects the slag launder 70 to the hot metal launder 38. The branch launder 95 is used to transfer molten metal that usually flows from the vessel

when the tap hole 46 is first opened to the metal containment pit 91. Prior to an end tap, the branch launder 72 is blocked so that molten material can only flow to the metal containment pit 91 via the branch launder 95. Towards the end of the metal flow, the branch launder 95 is blocked and the branch launder 72 is unblocked so that flow of molten material is diverted to the slag pit 93. A slag drain drill 68 is provided for opening the tap hole 46 to release slag from the vessel. A mud gun 66 is provided to close an open tap hole 46.

As is indicated above, the vessel includes a series of platforms 79, 81, 83, 85 at different heights of the vessel above ground level 87. The platforms enable installation and operation of vessel and other plant equipment.

The lowest platform, the end tap platform 85, is positioned in relation to the vessel 11 at a height that is selected so that workman on the platform can have convenient access to the end metal tapping system (metal end tap hole 63, launder 38, metal tap hole 43, launder 44, and end tap drill), the slag end tapping system (slag tap hole 46, launder 70, branch launder 95, slag drain drill 68, mud gun 66), and the access doors 39. Equipment such as the metal end tap drill, slag drain drill 68, and mud gun 66 are mounted directly on the platform. The platform also includes 2 overhead crane access areas 55 that are essentially clear spaces on and from which equipment and materials can be lifted, for example to facilitate re-lining the interior of the vessel 11.

The next highest platform, the cast house platform 83, is positioned in relation to the vessel 11 at a height that is selected so that workman on the platform can have convenient access to the metal tapping system (forehearth 19 and hot metal launder 41) and the slag

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tapping system (slag notch 21, launder 46, and slag notch plug and pricker machine 61). The footprint of the platform 83 is selectively formed so that the platform does not extend into the space above the overhead access areas 55 of the end tap platform 85 so that there is clear overhead crane access to these areas 55. The footprint of the platform 83 is also selectively formed so that the platform extends above the work areas in the immediate vicinity of the end metal and slag tapping systems and the access doors 39 on the end tap platform 85 to provide overhead protection for workman in these areas.

The next highest platforms, the lance extraction platforms 79, 81, are positioned in relation to the vessel 11 at heights that are selected so that workman on the platforms can have convenient access to the lances 27 and lance handling equipment to install and remove the lances 27 from the vessel.

The footprint of the platform 81 is shown in Figure 3. The footprint of the platform 81 is selectively formed so that the platform does not extend into the space above the overhead access areas 55 of the end tap platform 85 so that there is clear overhead crane access to these areas 55. The footprint is also selectively formed so that the platform extends above the work areas in the immediate vicinity of the metal and slag tapping systems to provide overhead protection for workman working in these areas.

In addition to the above-described plant equipment being arranged on a series of platforms 79, 81, 83, 85, the equipment is also arranged on the platforms within a series of circumferentially and vertically extending zones that further enable installation and operation of all the above-described equipment around the compact vessel 11 in a way which separates the various operational functions of the equipment so as to minimise

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interference between the various operations and, accordingly, maximising operational safety.

Specifically, the layout of the installation is divided into the following 3 functional zones that extend vertically and are spaced circumferentially around the vessel 11 and radiate outwardly of the central upright axis of the vessel.

Zone 1: General Access and Services

This zone, which extends approximately 180° around the circumference of the vessel 11 contains:-

- The footprints of the overhead hot gas delivery duct 31 and the offgas duct 32.
- The access doors 39 in the vessel 11.

Zone 2: Metal Tapping

This zone contains:-

- The slag tapping system (forehearth 19 and hot metal launder 41).
- The end metal tapping system (metal end tap hole 63, launder 38, metal tap hole 43, launder 44, and end tap drill).

Zone 3: Slag Tapping

This zone contains:-

- The slag tapping system (slag notch 21, launder 46, and slag notch plug and pricker machine 61).

- The slag end tapping system (slag tap hole 46, launder 70, branch launder 95, slag drain drill 68, and mud gun 66).

The plant also includes the zones, ie the space, above the above-described overhead crane access areas 55 that enable materials and equipment to be lifted onto and removed from the end tap platform. The overhead access is particularly important for efficient lifting of materials and equipment required for re-lining or other maintenance work on the interior of the vessel.

Many modifications may be made to the embodiment of the present invention described above without departing from the spirit and scope of the invention.

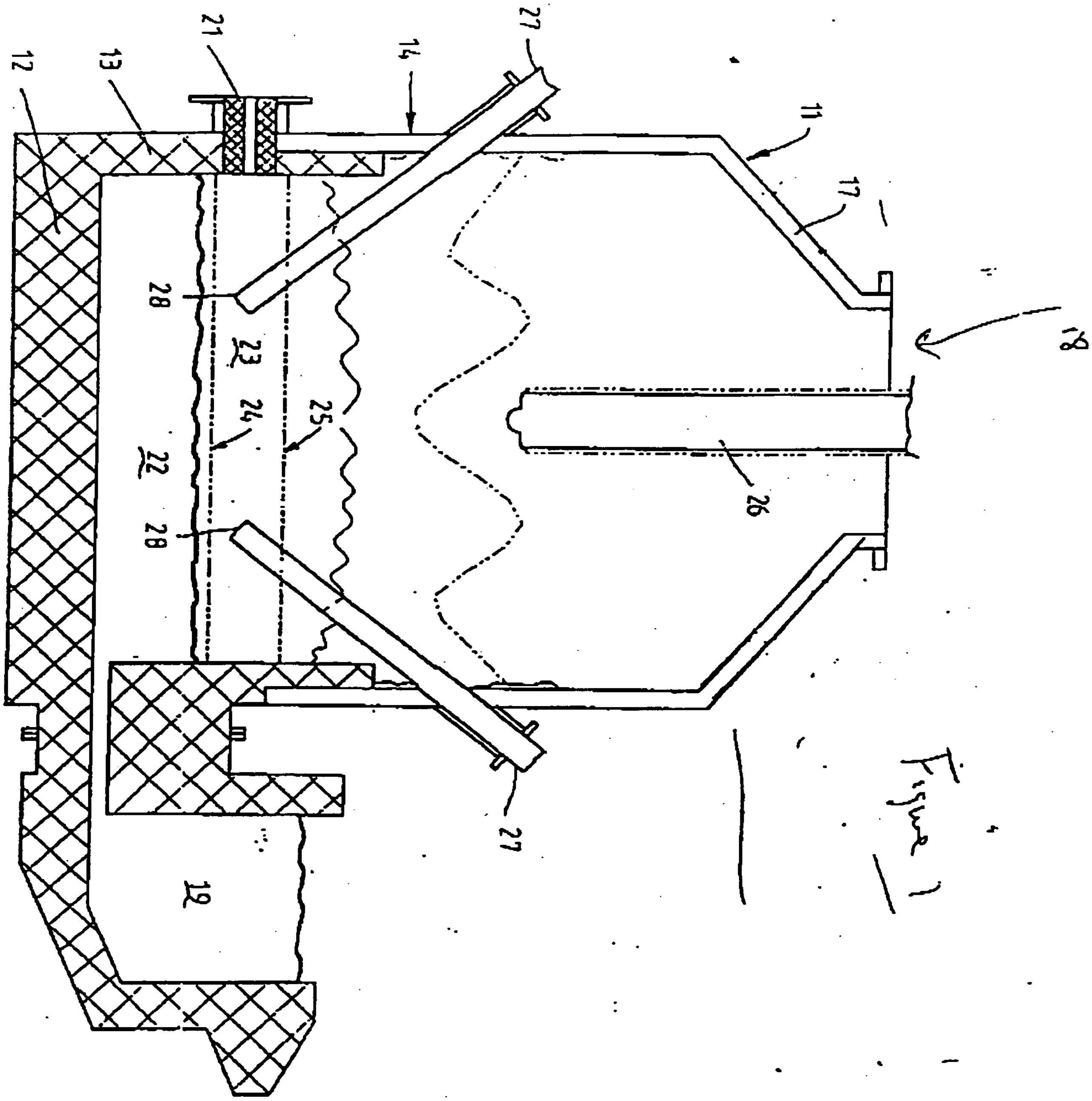


Figure 1

Figure 2

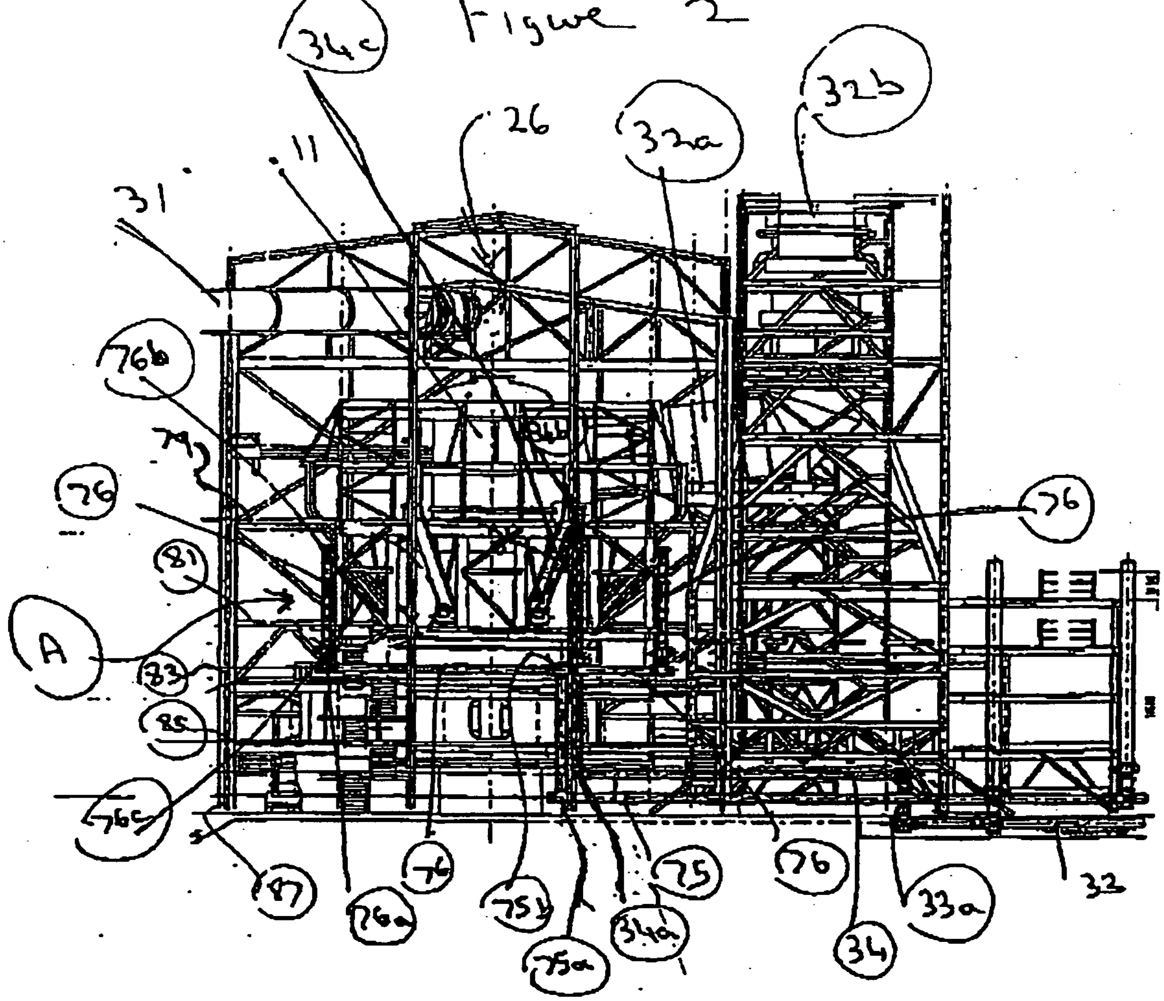


Figure 2a

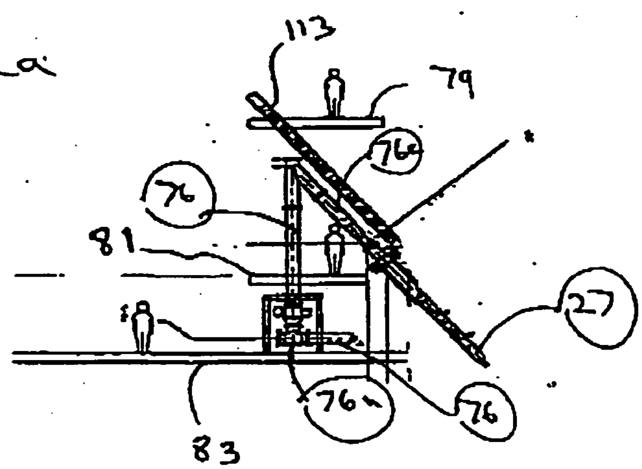
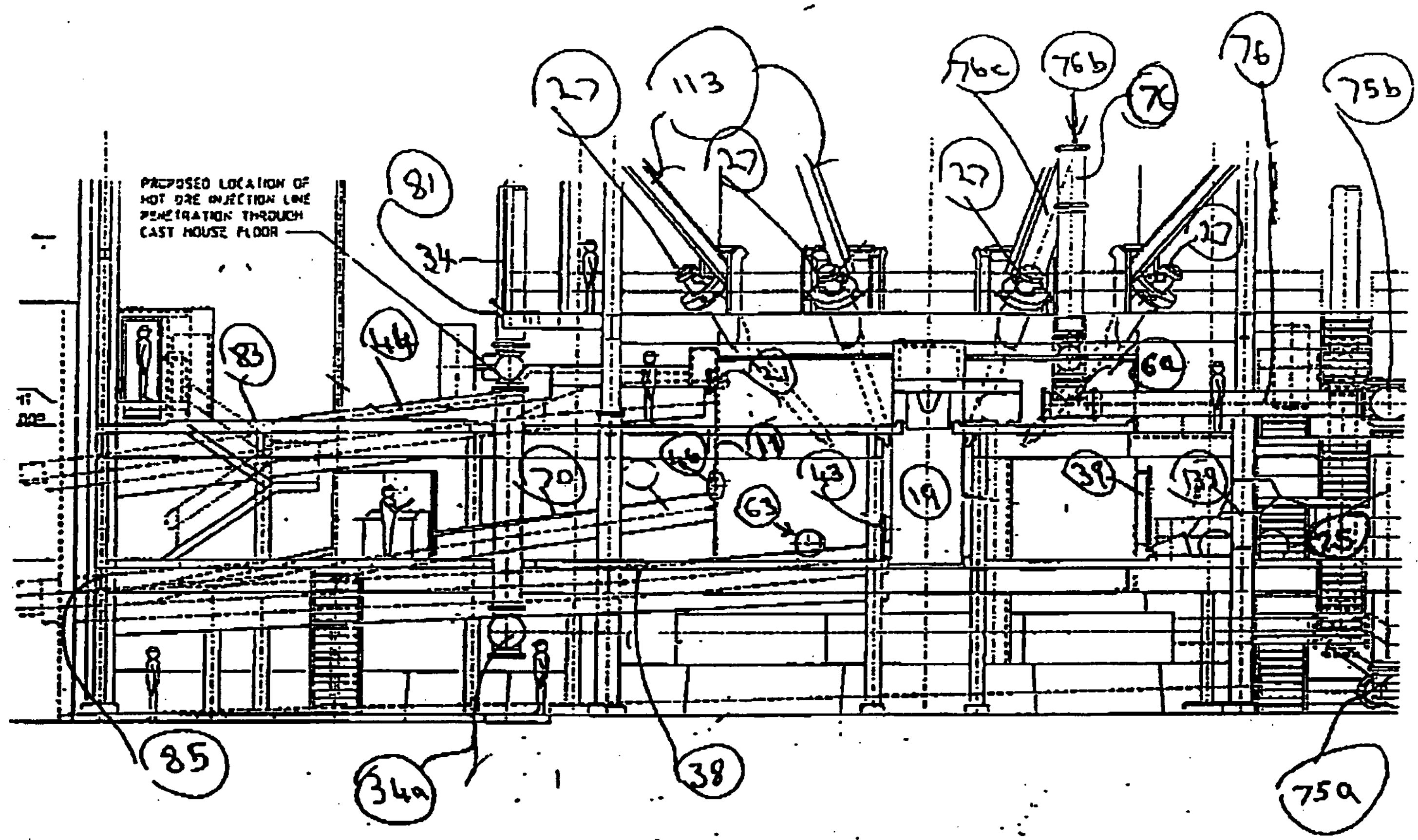


Figure 3



CENTRAL IRONMAKING UNIT (C.I.U)

Figure 4

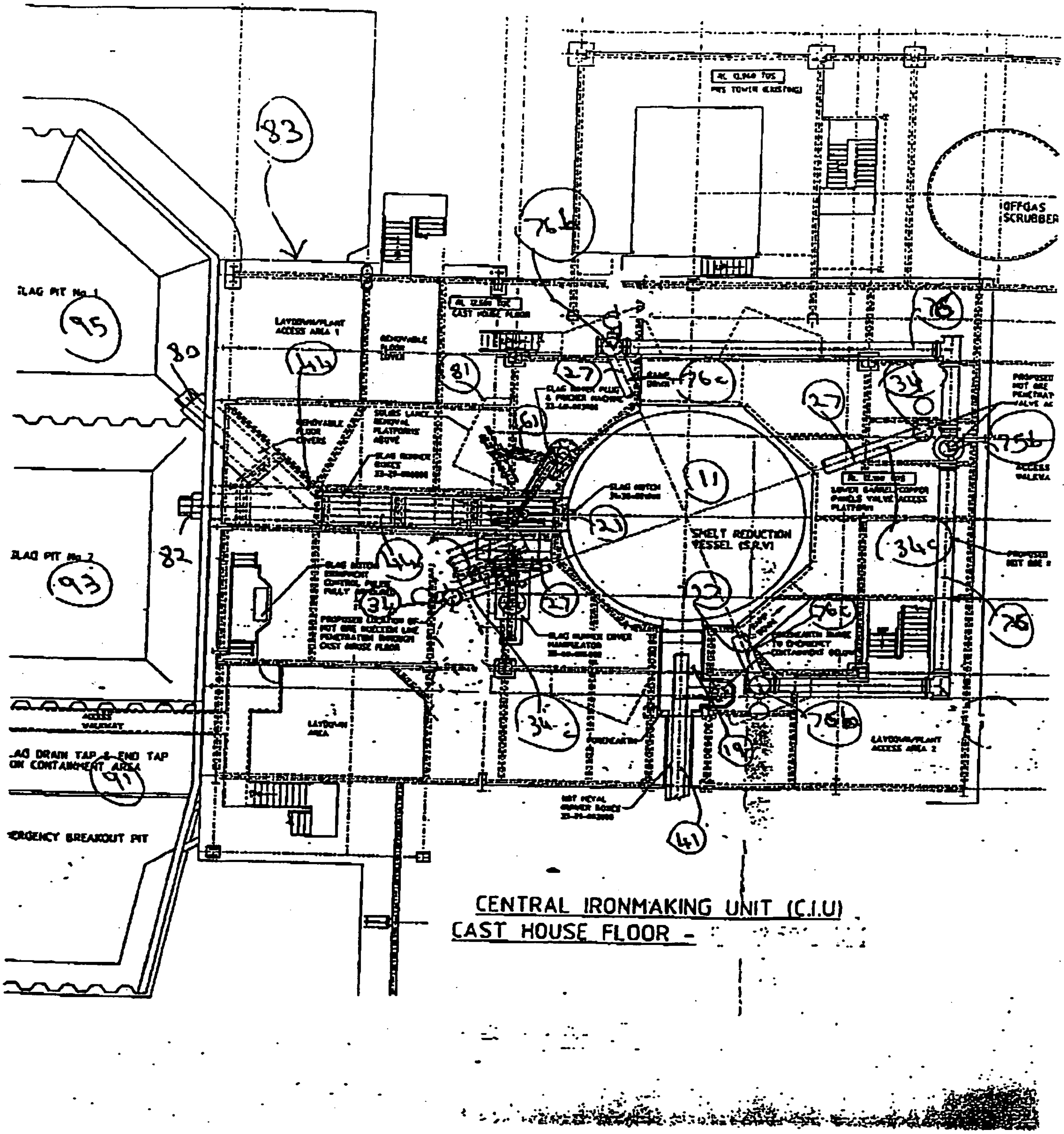
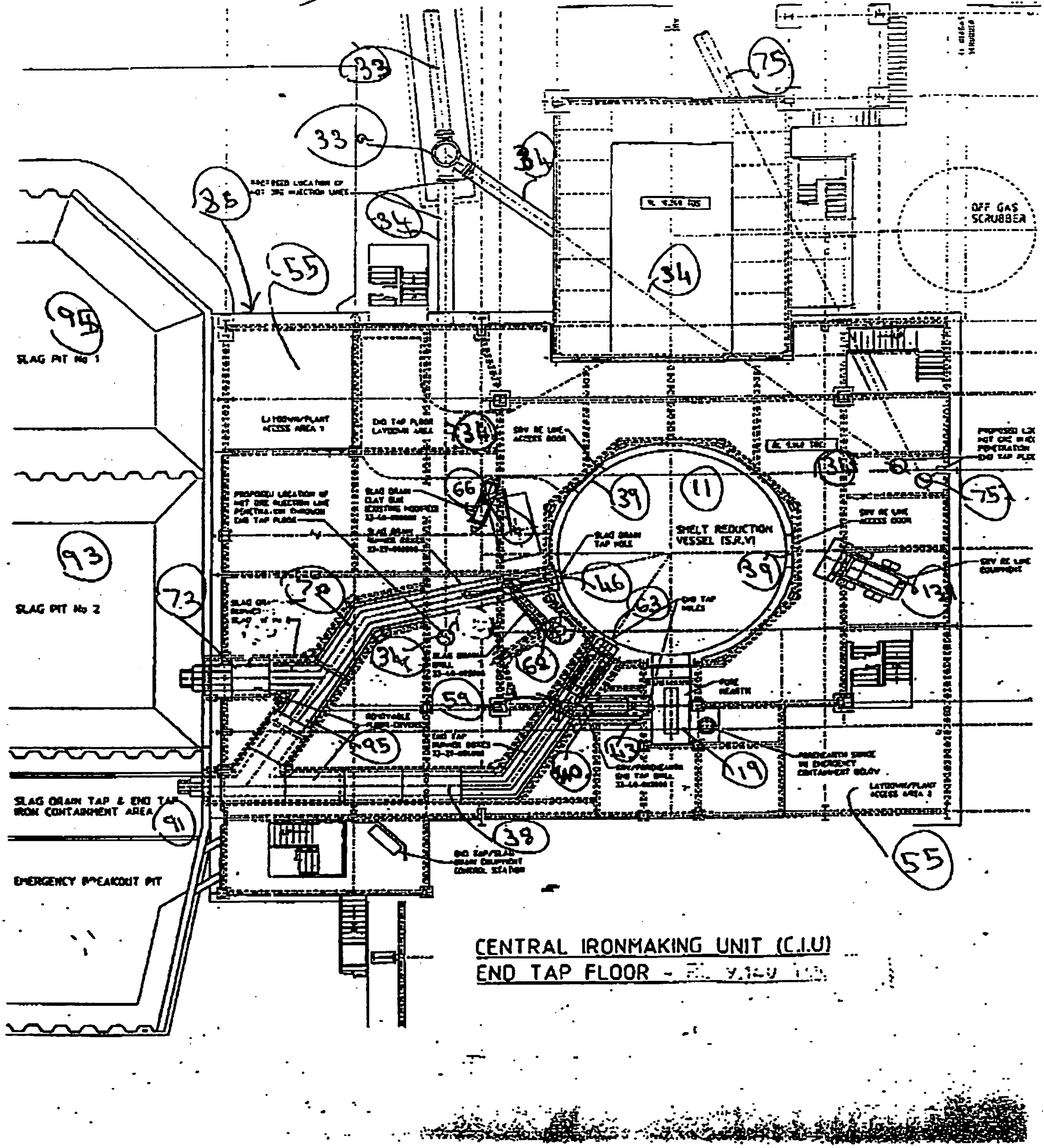

83
76b
OFFGAS SCRUBBER
SLAG PIT No. 1
95
80
CAST HOUSE FLOOR
76
41
81
27
76c
34
27
61
75b
11
SMELT REDUCTION VESSEL (S.R.V)
21
SLAG PIT No. 2
82
93
34a
31
27
22
76c
34c
76
34-2
75b
19
LAYDOWN AREA
LAYDOWN/PLANT ACCESS AREA 2
SLAG DRAIN TAP & END TAP ON CONTAINMENT AREA
91
EMERGENCY BREAKOUT PIT
41
CENTRAL IRONMAKING UNIT (C.I.U)
CAST HOUSE FLOOR -

Figure 5



CENTRAL IRONMAKING UNIT (C.I.U)
END TAP FLOOR

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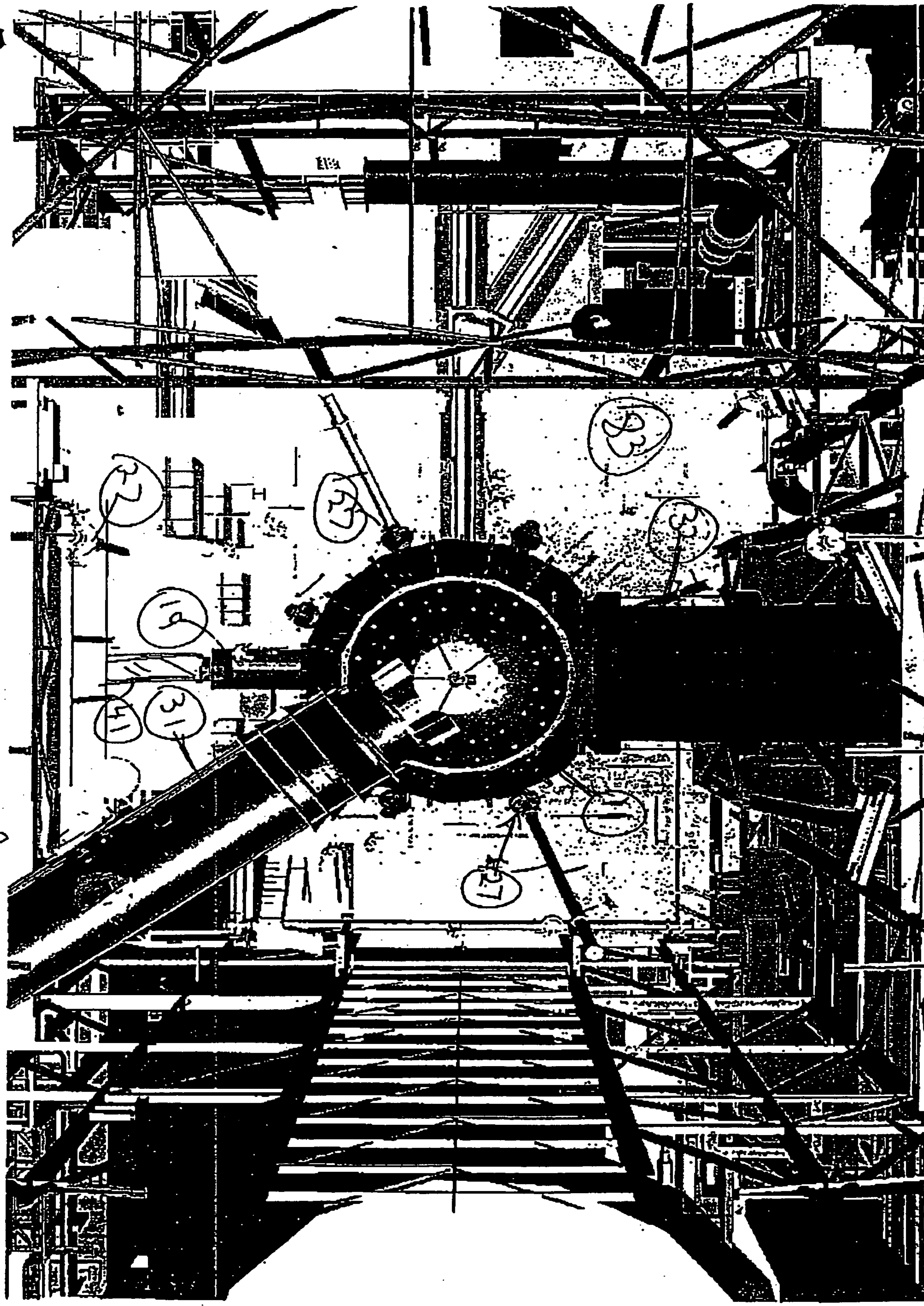

FIGURE 6

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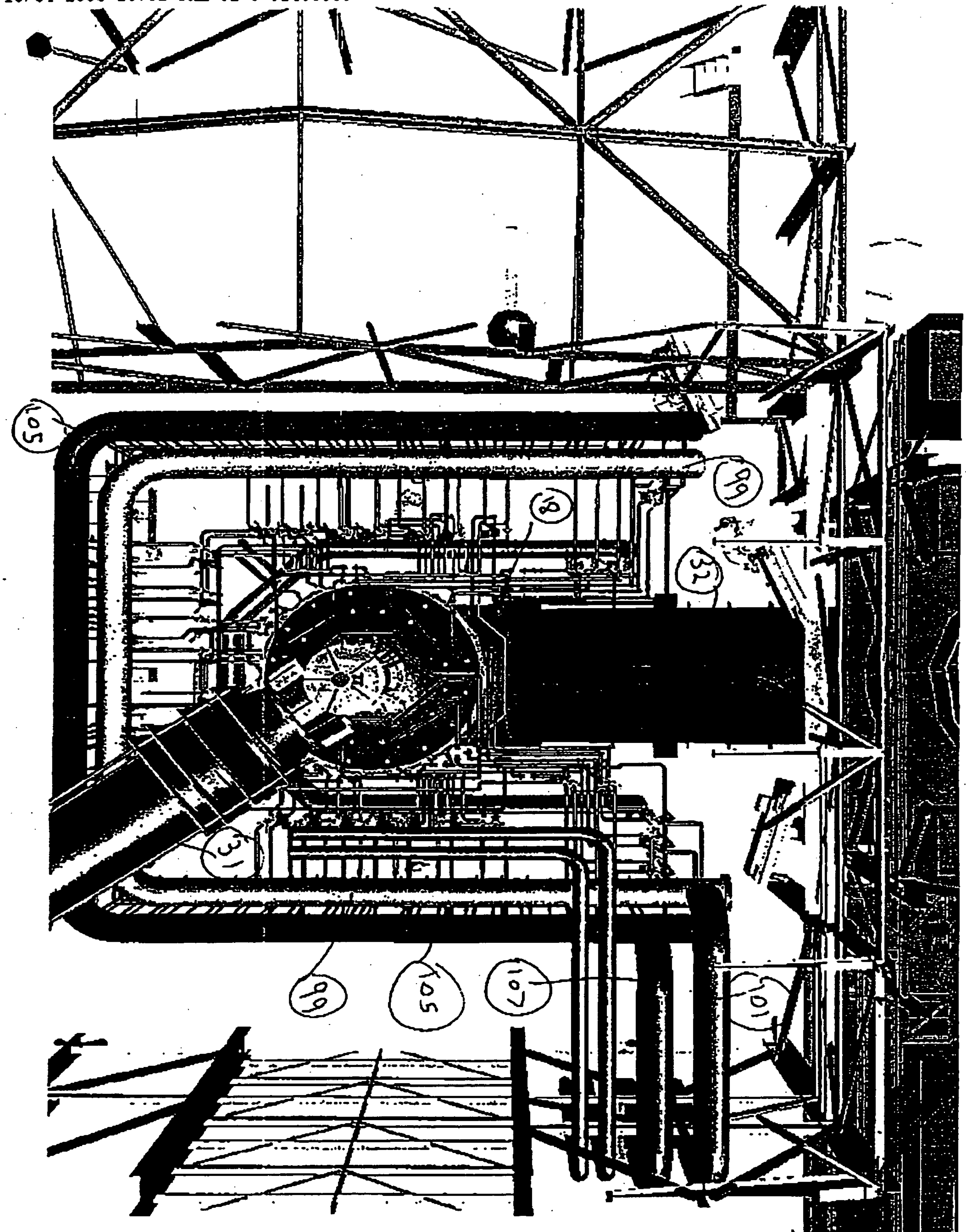

FIGURE 7

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Figure 8